ERS ***Staff Paper***

The Rural-Urban Gap in Manufacturing Productivity and Wages

Effects of Industry Mix and Region

Economic Research Service

Rural Economy Division

Number 9710

H. Frederick Gale, Jr.

The Rural-Urban Gap in Manufacturing Productivity and Wages: Effects of Industry Mix and Region. By H. Frederick Gale, Jr. Rural Economy Division, Economic Research Service, U.S. Department of Agriculture. Staff Paper No. 9710.

Abstract

This study analyzes urban and rural worker productivity and wages using unpublished 1992 Census of Manufactures data. A decomposition of regional averages separates out effects of regional industry mix from within-industry differentials over a rural-urban continuum and for metro and nonmetro portions of census regions. Industry mix accounts for about half of the rural-urban gap in both productivity and wages. After controlling for industry mix, both productivity and wages increase with urbanization. The size of the nonmetro gap in productivity and wages varies across regions. Comparison of actual 1991-93 employment growth with regional wage and productivity differentials shows that job growth occurred in regions with low wages.

Keywords: Rural manufacturing, regional economics, shift-share, labor productivity, wages

Acknowledgments

This research was done while the author was a research associate at the Center for Economic Studies, U.S. Bureau of the Census. Conclusions and opinions are not necessarily those of the Census Bureau or the U.S. Department of Agriculture. Gerald Schluter, Andy Bernat, and several anonymous reviewers provided helpful comments on this report.

Washington, DC 20005-4788

September 1997

Contents

The Rural-Urban Gap in Manufacturing Productivity and Wages: Effects of Industry Mix and Region

H. Frederick Gale, Jr.

Introduction

Information about wage and productivity differentials between rural and urban locations is important to assess the prospects for rural economic development and to improve our understanding of regional differences in earnings. Studies have consistently found that variables associated with labor cost are one of the most important factors influencing firm location (Blair and Premus, 1987). However, little information is currently available. Regional differences in wages are sometimes available, but a complete analysis must consider wages and productivity together (Fogarty and Garofalo, 1978; Moomaw, 1983).

Comparisons of average wages and productivity across regions can be misleading, because they partly reflect differences in the structure, or mix, of industries in rural and urban regions (Norcliffe, 1977). Consistent with product cycle theory, or "filtering down," mature labor-intensive industries are more likely to choose rural locations because they are more sensitive to labor costs, and have less need of skilled labor or access to innovations (Barkley, 1995; Campbell, 1995; Miller, 1989; Markusen, 1985). Consequently, rural regions have an industry mix that is more heavily weighted toward low-wage and low-productivity labor-intensive industries, such as textiles, apparel, leather, lumber and wood products. Regional comparisons of the relative productivity and wages of workers in similar industries can be improved by controlling for the industry mix effect.

This study estimates the magnitude of wage and productivity differentials between rural and urban manufacturing workers. Manufacturing now forms the economic base of many rural communities, and nearly all net growth in manufacturing jobs has been in rural areas during recent years (Bernat, 1994). Average wages and value-added per worker computed from unpublished 1992 Census of Manufactures data provide more detail than is available from published sources, which do not report rural averages. A shift-share method employed by Norcliffe and Mitchell (1977) and Ledebur and Moomaw (1983) is used to decompose rural and urban wages and output per worker into an industry mix effect and a residual component that represents the within-industry regional differential. By removing the industry mix effect, the within-industry differential can give us a better idea of how wages and productivity in similar industries compare across regions. Further homogeneity is achieved by analyzing production worker and nonproduction worker earnings separately. I also compare regional job growth with wage and productivity differentials to determine whether jobs are currently moving toward low-wage or high-productivity regions.

Decomposition of Regional Averages

Ledebur and Moomaw (1983), Norcliffe (1977), and Norcliffe and Mitchell (1977) developed a shift-share method to analyze regional differences in productivity. While shift-share is normally used for isolating the various factors associated with changes in income and employment (Curtis, 1972), the technique is adapted here to decompose regional averages at a single point in time. I am interested in comparing the average productivity or wage, $V_{\cdot j}$, for various regions, where j represents sets of regions specified below. The regional average can be apportioned into an industry mix component and a residual component that represents the relative productivity/wage of establishments in the region compared with those in the same industry in other regions. I begin by summing establishment values within each industry and region to obtain V_{ij}, the average value for industry i in region j. There are N industries and R regions, for a total of NR values of V_{ij}. I then compute means by region and industry, where $V_{\cdot\cdot}$ is the national average (1 mean), $V_{\cdot j}$ is the average for region j (R means), $V_{i\cdot}$ is the national average for industry i (one for each of N industries). I also compute NR shares, t_{ij}, the employment share of industry i within region j, where $\Sigma_i\, t_{ij}=1$. This study performs shift-share analysis for two sets of regions: Beale codes (R=10), and metro-nonmetro portions of census regions (R=18). The level of industry detail used for the shift-share analysis is the 3-digit SIC code--roughly 180 industries.

Following Ledebur and Moomaw, I use simple algebra to decompose the regional average, $V_{\cdot j}$, using two identities. By definition, $V_{\cdot j}$ is the sum of industry averages in the region weighted by their shares, t_{ij}:

$$V_{\cdot j} = \sum_{i=1}^{N} t_{ij}\, V_{ij} \,. \qquad (1)$$

The decomposition of $V_{\cdot j}$ is derived by adding and subtracting equivalent terms on the right-hand side of equation (1),[1]

$$V_{\cdot j} = V_{\cdot\cdot} + \sum_{i=1}^{N} t_{ij}(V_{i\cdot} - V_{\cdot\cdot}) + \sum_{i=1}^{N} t_{ij}(V_{ij} - V_{i\cdot}). \qquad (2)$$

The regional average has three components. The national average, $V_{\cdot\cdot}$, is the first component. The second is the region's industry mix component. The term ($V_{i\cdot}$ - $V_{\cdot\cdot}$) is the difference

---

[1]Note that $\sum_{i=1}^{N} t_{ij}V_{\cdot\cdot} = V_{\cdot\cdot}$, *since* $\sum_{i=1}^{N} t_{ij} = 1$. Add and subtract equivalent terms:

$V_{\cdot j} = \Sigma_i\, t_{ij}V_{ij} + V_{\cdot\cdot} - \Sigma_i\, t_{ij}V_{\cdot\cdot} + \Sigma_i\, t_{ij}V_{i\cdot} - \Sigma_i\, t_{ij}V_{i\cdot}$. Rearranging this equation results in equation 2.

between the average productivity/wage in industry i and V.., the overall average. These differences are summed using the region's employment shares for each industry as weights. The industry mix component will be negative if a region has a large share of employment in industries with low productivity/wages, (where $V_{i.}$-V..<0), and it will be positive for a region with employment concentrated in high-productivity/wage industries.

The third component of (2) is a residual that I will call the within-industry component. This term evaluates the productivity/wage of each industry in region j relative to the national average for that industry. When industry i's productivity/wage is relatively low in region j, the term (V_{ij} - $V_{i.}$) is negative. These within-industry relative productivity differences are summed across industries in the region, weighted by industry employment shares in region j. The within-industry component is negative when industries in region j systematically have relatively low productivity/wages compared with the national average for their industry, and positive when region j's industries tend to have productivity or wages exceeding the national average. Note that if region j's industry mix is equal to the national industry mix, the industry mix term is zero.[2] The within-industry component goes to zero when $V_{ij} = V_{i.}$ for each industry in region j. When both the industry mix and within-industry components are zero, $V_{.j}$, the regional average, equals V.., the national average.

Finally, the shift-share equation is converted to percentage form. Dividing through by V.. and multiplying by 100 results in an index for each region:

$$Index_j = 100 + (Industry\ Mix\ Component_j) + (Within\text{-}Industry\ Component_j). \qquad (3)$$

The index will equal 100 when the regional average equals the national average. The industry mix and within-industry components are reported as percentages of V.., the national average. An industry mix component greater than zero indicates that the region has attracted industries with relatively high productivity/wages. This is usually an indicator of the capital intensity of the local industries. A within-industry component greater than zero indicates that the productivity/wages of plants in the region tends to be higher than plants in the same industry located elsewhere.

Data

This study employs unpublished data from the 1992 Census of Manufactures to analyze production worker hourly wages and value-added per worker. Wages are computed by dividing total production worker wages by production worker hours. Census value-added is the gross margin between receipts and the value of materials purchased (Israilevich and Testa, 1989; U.S. Bureau of the Census). Value-added per worker is a convenient measure of worker productivity.

---

[2]To see this, recognize that $\Sigma_i t_{ij} V_{i.} = V..$ if the shares t_{ij} are equal to the national shares, $t_{i.}$, used to compute V.. Also, recall that $\Sigma_i t_{ij} V..=V..$, since $\Sigma_i t_{ij}=1$. Then $\Sigma_i t_{ij} V_{i.} - \Sigma_i t_{ij} V.. = 0$.

The appendix of this study discusses the shortcomings of value-added for geographic comparisons of productivity.

The productivity measure does not differentiate between different types of workers, but earnings of production and nonproduction workers were analyzed separately. When considering a location for a manufacturing plant, the cost or quality of production workers at a particular location is generally an important consideration, while management and technical personnel (nonproduction workers) are often recruited from other locations.

County data were summed to 3-digit industry totals for each of the larger regions used in the analysis: Beale codes and metro-nonmetro portions of census divisions. The 1993 Beale codes shown in table 1 are a rural-urban continuum that classifies all U.S. counties into 10 groups based on degree of urbanization (Butler, 1994). Counties were first classified on the basis of whether they are part of a standard metropolitan statistical area (SMSA). Metro counties were grouped based on the size of the metropolitan area where they are located--small, medium, or large. Counties in large metro areas were separated into "fringe" and "core" counties. Nonmetro areas were classified into three classes of urbanization based on the amount of population that lives in urban places (towns or cities) in the county. The classes are 20,000 or more (urbanized), 2,500-19,999 (less urbanized), and under 2,500 (completely rural). These three classes were then split into two groups each, depending on whether they are adjacent to a metro area or not. Most research uses metro-nonmetro as the definition of rural-urban, but the Beale codes provide a more detailed measure of degree of urbanization for U.S. counties. The initial shift-share analysis treats each Beale code as a region. Subsequent analysis focuses on regional differences in rural-urban productivity and wages by performing the decomposition analysis for metro and nonmetro portions of the nine census divisions shown in figure 1.

Decomposition Results

By Beale Code

Table 2 shows the labor shares and decomposition results for the Beale code rural-urban continuum. The share of production worker hours in each Beale code is shown to evaluate the relative importance of each class of counties in the national averages. The two classes representing large and medium-sized metro areas account for over 60 percent of production activity. Metro areas of all sizes account for nearly three-fourths of all production worker hours.[3]

The index values in table 2 suggest a wide rural-urban differential in both wages and

---

[3]The heavy weight given to metro regions explains why only one or two regions have values above the national average in many of the analyses that follow. Note also that, as pointed out by Israilevich and Testa, the actual contribution of urban areas to manufacturing output is even greater than their share of production worker hours, since an even greater share of nonproduction workers is in urban areas.

productivity. Wages are 28 percent below the national average in the most rural counties and 8 percent above the average in the most urbanized counties. However, the decomposition shows that this "raw" differential of 36 percentage points between the most rural and most urban places is narrowed to about 19 percentage points after controlling for industry mix. Industry mix reinforces within-industry differentials and accounts for about half of rural-urban differences in productivity and wages. After removing the industry-mix component, a rural-urban gradient in productivity and wages is still apparent, but it is less steep. The within-industry components show a narrower differential of 14 percent in both productivity and wages for the most rural counties. The within-industry component for core metro counties is 5 percent for wages and 4 percent for value-added per worker. The other three metro types and nonmetro urbanized adjacent counties are similar--each has small within-industry differentials. Nonmetro counties with lower degrees of urbanization have larger negative within-industry components in both productivity and wages. Nonmetro counties that are adjacent to a metro area have higher productivity and wages than nonadjacent counties with the same degree of urbanization. The differential is generally 2 to 4 percentage points.

Industry-mix components also generally increase with urbanization. More urbanized counties tend to attract manufacturing establishments from industries with relatively high productivity and wages. The pattern is clear for wages. The industry-mix wage component falls from +3 percent for core metro counties to -15 percent for rural adjacent counties. For productivity, the industry-mix components generally fall as counties become more rural, but there are some exceptions. The industry-mix productivity component is highest in medium-sized metro areas, while core metro counties have an industry-mix component of zero. Another exception is the positive industry-mix component for urbanized nonadjacent counties.

By Metro-Nonmetro Region

Table 3 shows labor shares and regional decomposition results for metro and nonmetro portions of the nine census divisions. The regional shares of production labor show that production is concentrated in metro areas, particularly in the East North Central, Pacific, Mid-Atlantic, and South Atlantic regions. Nonmetro production labor is concentrated in southern regions and the East and West North Central regions.

Index values indicate that nonmetro value-added per worker and wages are systematically lower than metro values. Index values show that metro areas in each region except New England have value-added per worker above the national average.[4] All nonmetro regions fall below the U.S. average. Nonmetro wages tend to be lower than metro wages, but one nonmetro region--the Pacific--has wages above the national average and three metro regions have wages slightly

---

[4]The Israilevich and Testa criticism may explain the low value-added in the metro New England region, since many corporate headquarters and research and development units are located in this region. Ledebur and Moomaw and Peterson and Muller also found low productivity in New England. The metro Mid-Atlantic and Pacific regions have high concentrations of nonproduction workers, so their productivity may also be biased downward.

below the national average. Again, wide differences among regions are apparent. Wage and productivity indexes range from 77 to 118. Removing the industry-mix effect narrows the differentials, but there is still substantial variation among regions.

Within-industry components show that nonmetro portions of regions tend to have lower wages and productivity, but the magnitude of the gap varies from region to region. Nonmetro productivity is only 2 percent below the national average in the East North Central region, compared with 19 percent in the nonmetro Mountain region. The within-industry wage component for nonmetro regions is as high as -4 to -5 percent in New England, Mid-Atlantic, and East North Central, and is as low as -11 to -12 percent in the West North Central, East South Central, and West South Central regions. The nonmetro Pacific region has a puzzling within-industry wage component of +10 percent. Inspection of the data showed that the high averages in this region are due to very high wages in nonmetro Washington State. Wages in other nonmetro Pacific States were more in line with those in other nonmetro regions.

Most metro regions have positive within-industry components. However, four metro regions have components of -4 to -5 percent--South Atlantic, East and West South Central and the Mountain region. The highest within-industry productivity component is in the metro West South Central region, but the within-industry wage component in that region is -4. The high output per worker in the metro West South Central region is probably due to the importance of the capital-intensive petroleum industry in that region. The highest within-industry wage component is in the metro East North Central region. This reflects the concentration of unionized skilled workers in what is often considered the Nation's traditional "manufacturing belt."

Industry-mix tends to favor metro regions, making a positive contribution to average productivity in five metro regions and only two nonmetro regions. Industry mix has a negative effect in seven nonmetro regions. Industry-mix wage components also tend to be positive in metro regions and negative in nonmetro regions. The largest negative industry-mix components for both productivity and wages are in the nonmetro South Atlantic and East South Central regions. It is interesting to note, however, that this concentration of low-productivity industry in the South is not observed in the metro portions of the southern regions. In fact, the metro West South Central, East South Central, and South Atlantic have the largest positive industry-mix productivity components. These results agree with anecdotal evidence in the popular press that the "New South" economic phenomenon is largely confined to urban areas, resulting in a widening rural-urban gap in the South.

Nonproduction Worker Salaries and Wages

Nonproduction worker salaries are highest in the metro New England, Mid-Atlantic, and Pacific regions (table 4). This reflects the concentration of headquarters, research and development, and other technical, legal, and management operations in those regions. This is also consistent with the "spatial division of labor" described by Miller (1980) and Hansen (1979). The location of large corporations in the Northeast and West Coast may push up average nonproduction worker

salaries in those regions. Large corporations located in those regions likely have higher-salaried executives and larger legal, accounting, and R&D staffs than companies headquartered in other regions. All nonmetro regions have negative industry-mix and within-industry wage components. Nonproduction worker salaries range from 11 percent under the national average in the nonmetro East North Central to 24 percent under the national average in the West North Central, East South Central, and Mountain regions. The negative within-industry wage component for nonmetro regions further reflects the location of routine production operations in rural areas. The nonproduction workforce in these areas is likely more heavily composed of clerical and other low-paid personnel than is the workforce in urban establishments.

Product cycle theory suggests a "spatial division of labor" (Barkley, 1995; Hansen, 1979; Miller, 1989), where nonproduction workers are concentrated in urbanized areas and production workers are relatively concentrated in outlying regions. Researchers often use nonproduction workers as a proxy for skilled labor, while production workers are usually considered unskilled labor.[5] The regional shares of nonproduction workers and production worker hours confirm a spatial division of labor. Only 13.5 percent of nonproduction (skilled) workers are located in nonmetro regions, while more than one-fourth of production worker (unskilled) hours are in nonmetro regions. In eight of nine metro regions, the share of nonproduction workers exceeds the share of production worker hours, while the share of production worker hours exceeds the nonproduction worker share in all nonmetro regions. Nonproduction workers are concentrated in the metro East North Central (19.0 percent), as is production labor (17.8 percent). This region is the Nation's historical "manufacturing belt." The metro Mid-Atlantic and Pacific regions have the second highest concentration of nonproduction workers (15 percent each) and the greatest imbalance between nonproduction and production labor (nearly 4 percentage points). This reflects the location of headquarters, other management, sales, research, and auxiliary functions in the Northeast and on the west coast.

Productivity, Wages, and Employment Growth

Is manufacturing activity shifting toward regions with low wages or those with high productivity? In this section, I address these questions by comparing within-industry productivity and production worker wage differentials across regions with patterns of manufacturing employment growth from 1991 to 1993, a period that brackets the year of the data, 1992, and coincides with the recovery from the 1990-91 recession. Regional manufacturing employment measures were constructed from unpublished county-level Bureau of Economic Analysis data.

In the early 1990's, manufacturing employment fell in urban places (where wages and productivity are high), and grew in more rural places (where wages and productivity are low). Table 5 shows that core metro areas lost over 400,000 manufacturing jobs (5 percent) and

---

[5]Leamer has criticized the use of production-nonproduction workers as a proxy for skilled-unskilled workers, but the availability of this variable and lack of other information on workforce make this a convenient measure.

medium metro areas lost 26,000 (0.6 percent). All other county types gained manufacturing jobs, including a gain of nearly 128,000 jobs in nonmetro counties. The bulk of the job gain was in less urbanized nonmetro counties, which gained over 90,000 jobs. Completely rural areas posted job gains that were small in magnitude but large in percentage terms (4-5 percent). Data by region also show strong manufacturing job growth in nonmetro portions of regions and decline in metro portions. It seems clear that urban productivity advantages did not attract manufacturing employment over 1991-93. Job growth occurred in more rural parts of the United States where wages are relatively low, despite lower productivity.

Figure 2 plots manufacturing job growth rates against within-industry wage differentials for each of the ten Beale codes. A clear negative association between job growth and wage level is apparent, as low-wage (rural) regions added manufacturing jobs at a faster rate than high-wage (urban) regions. Figure 3 shows a weaker, but still negative, relationship between job growth and wages for metro-nonmetro portions of census regions. Nonmetro regions tend to have negative wage differentials and positive employment growth, while the opposite is true for most metro regions. Of the four metro regions that had negative wage differentials, two showed little change in employment and the other two were the only metro regions to show significant job growth. The New England and Mid-Atlantic regions were the only nonmetro regions showing significant job loss. The negative relationship between wages and job growth is more apparent if the nonmetro Pacific and metro East North Central regions are excluded. These two regions had unusually large positive wage differentials of 9 and 10 percent, respectively, and showed little change in employment. The other 16 regions show a clear negative relationship between job growth and wages.

Since the wage and productivity differentials are closely related, the relationship between job growth and productivity is also negative. Regions with relatively high value-added per worker lost manufacturing jobs, apparently due to their high wage structure. This suggests that low wages (or some characteristic that is correlated with wages) were more important than high productivity in attracting manufacturing jobs during 1991-93.

Conclusion

Rural manufacturing establishments pay their workers considerably less than their urban counterparts. After adjusting for the mix of industries, production worker wages in the most rural areas tend to be 14 percent below the national average for workers in the same industry. Wages tend to be low in nonmetro areas of all regions, but they are particularly low in the South Central and West North Central regions. These wage differentials suggest substantial cost savings for firms relocating to these regions from high-wage urban locations where wages are 5 percent above the average. However, cost savings would be offset by lower worker productivity, as measured by value-added per worker, which is also 14 percent below the average in the most rural areas.

This study did not directly investigate the source of productivity and wage differentials between rural and urban areas. Does higher urban productivity, due to agglomeration economies or other

reasons, lead to higher urban wages? Or, must urban residents be paid higher wages to compensate for urban disamenities and higher costs of living, resulting in higher urban productivity? These two questions pose a "chicken-and-egg" dilemma, i.e., "Which came first, higher urban productivity or higher urban wages?" It is difficult to address these questions of causation in the cross-sectional comparisons performed here.

The mix of manufacturing industry in rural areas is heavily weighted toward low-wage/low-productivity industries. Similarly, highly paid and skilled nonproduction workers (managment, technical, sales, etc.) are concentrated in large urban areas while rural manufacturing workers tend to be less-skilled production workers. These patterns are consistent with the product cycle or "filtering down" theories of manufacturing location, and provide further evidence that the rural competitive advantage is in low-wage industry. This also implies that nonmetro areas are vulnerable to competition from overseas locations where wages are even lower. Some shifting of manufacturing jobs from urban to rural areas has occurred in the 1990's, but rural areas have only gained a fraction of the urban jobs lost to foreign competition and downsizing. The apparel industry, perhaps the most labor-intensive manufacturing industry in the United States and a large rural employer, has generally declined in the face of low-wage foreign competition. On the other hand, the North American Free Trade Agreement (NAFTA) has, so far, failed to produce the dramatic southward exodus of jobs to low-wage Mexican locations predicted by NAFTA's opponents. Clearly, wages are not the only factor determining industrial location. Worker productivity, transportation infrastructure, access to suppliers and markets, tax rates, and regulatory and risk considerations are also important.

References

Barkley, D.L. "The Economics of Change in Rural America." *American Journal of Agricultural Economics* 77(December 1995): 1252-1258.

Bernat, G.A. "Manufacturing Restructuring and Rural Economies: Job Growth But Lagging Wages." *Rural Development Perspectives* 9(June 1994): 2-8.

Blair, J.P. and R. Premus. "Major Factors in Industrial Location: A Review." *Economic Development Quarterly* 1(1987): 72-85.

Butler, M.A. *Rural-Urban Continuum Codes for Metro and Nonmetro Counties, 1993.* USDA-ERS Staff Report No. AGES 9425. September 1994.

Campbell, C.A. "Industrial Filtering in a Nonmetropolitan Area of the South." *The Review of Regional Studies* 25(1995): 219-235.

Ciccone, Antonio, and R.E. Hall. "Productivity and the Density of Economic Activity." *American Economic Review* 86(March 1996): 54-70.

Curtis, W.C. "Shift-Share Analysis as a Technique in Rural Development Research." *American Journal of Agricultural Economics* 54(1972): 267-270.

Fogarty, M.S., and G. Garofalo. "An Exploration of the Real Productivity Effects of Cities." *The Review of Regional Studies* 8(1978): 65-82.

Gale, F. "Manufacturing Jobs Continued Shift to Nonmetro Areas in 1993." *Rural Conditions and Trends* 7(July 1996): 33-38.

Hansen, N. "The New International Division of Labor and Manufacturing Decentralization in the United States." *The Review of Regional Studies* 9(Spring 1979): 35-48.

Israilevich, P.R., and W.A. Testa. "The Geography of Value Added." *Economic Perspectives* (September-October 1989): 2-12.

Leamer, E.E. "Trade, Wages, and Revolving Door Ideas." NBER Working Paper 4716. April 1994.

Ledebur, L.C., and R.L. Moomaw. "A Shift-Share Analysis of Regional Labor Productivity in Manufacturing." *Growth and Change* 10 (January 1983): 2-9.

Markusen, A. *Profit Cycles, Oligopoly, and Regional Development.* Cambridge, MA: The MIT Press, 1985.

Miller, J.P. "The Product Cycle and High Technology Industry in Nonmetropolitan Areas, 1976-1980." *Review of Regional Studies* 19(Winter 1989): 1-12.

Moomaw, R.L. "Spatial Productivity Variations in Manufacturing: A Critical Survey of Cross-Sectional Analysis." *International Regional Science Review* 8(1983): 1-22.

Norcliffe, G.B. "A Components Model for Disaggregating Regional Productivity Variations." *Regional Studies* 11(1977): 395-400.

Norcliffe, G.B., and P. Mitchell. "Structural Effects and Provincial Productivity Variations in Canadian Manufacturing Industry." *Canadian Journal of Economics* 10(1977): 695-701.

Peterson, G.E., and T. Muller. "The Economic and Fiscal Accompaniments of Population Change." In *Population Redistribution and Public Policy,* ed. B.J.L. Berry and L.P. Silverman. Washington, DC: National Academy of Sciences, 1980. pp. 70-113.

U.S. Bureau of the Census. *Annual Survey of Manufactures.* Various issues.

Table 1. Beale code rural-urban continuum and basic manufacturing statistics, 1992

Beale code		Manufacturing employment	Value-added per worker	Hourly wage[1]
		1,000	*1,000 dollars*	*dollars*
Metro counties:				
Core metro	Central counties of a metro area with population 1 million or more	8,042	81.0	12.88
Fringe metro	Fringe counties of a metro area of population 1 million or more	546	78.9	11.82
Medium metro	Metro areas of population 250,000 - 1 million	4,243	82.2	12.42
Small metro	Metro areas of population under 250,000	1,472	80.3	11.76
Nonmetro counties:				
Urbanized	Largest urban place has population 20,000 or more			
Adjacent to metro		890	74.1	11.36
Not Adjacent		420	73.5	10.88
Less urbanized	Largest urban place has population 2,500-19,999			
Adjacent to metro		1,311	66.5	10.01
Not adjacent		982	61.3	9.55
Completely rural	Largest urban place has population under 2,500			
Adjacent to metro		137	56.8	8.99
Not adjacent		169	56.2	8.62

[1] Production workers only.

Source: Butler (1990); analysis of unpublished U.S. Bureau of the Census, 1992 Census of Manufactures.

Table 2. Decomposition analysis of value-added per worker and production worker wages by Beale code, 1992

Beale Code	Share of production labor[1]	Labor productivity[2]			Production worker wages		
		Index	Industry mix	Within-industry	Index	Industry mix	Within-industry
				Percent			
Metro							
Core	38.7	104	0	4	108	3	5
Fringe	3.3	101	2	-1	99	1	-2
Medium	23.5	105	6	-1	104	2	2
Small	8.8	103	4	-1	99	1	-2
Nonmetro							
Urbanized adjacent[3]	5.6	95	-4	-1	95	-3	-2
Urbanized nonadjacent	2.7	94	2	-8	91	-3	-6
Less urbanized adjacent[3]	8.7	85	-8	-7	84	-7	-9
Less urbanized nonadjacent	6.6	79	-10	-11	80	-9	-11
Rural adjacent[3]	0.9	73	-16	-11	75	-15	-10
Rural nonadjacent	1.1	72	-14	-14	72	-14	-14

Note: Table shows regional average productivity/wage relative to national average. Index = 100 + industry-mix component + within-industry component.

[1]Share of national production worker hours. [2]Value-added per worker. [3]Adjacent to metro area.

Source: Analysis of unpublished 1992 Census of Manufactures data.

Table 3. Regional decomposition analysis of metro-nonmetro value-added per worker and production worker wages by region, 1992

Beale Code	Share of production labor[1]	Labor productivity[2]			Production worker wages		
		Index	Industry mix	Within-industry	Index	Industry mix	Within-industry
	Percent						
Metro							
New England	4.7	95	-3	-2	107	2	6
Mid-Atlantic	11.4	102	-1	3	103	-2	5
East North Central	17.8	102	-2	5	118	9	9
West North Central	4.4	105	0	5	108	4	4
South Atlantic	11.4	107	7	0	94	-3	-4
East South Central	4.1	106	9	-3	99	4	-5
West South Central	6.4	118	10	8	101	5	-4
Mountain	2.5	104	5	-1	99	3	-4
Pacific	11.7	101	2	-1	102	0	2
Nonmetro							
New England	1.0	81	-7	-12	96	0	-4
Mid-Atlantic	1.4	86	-6	-8	91	-4	-5
East North Central	5.2	95	-2	-2	97	2	-5
West North Central	3.1	93	-3	-4	83	-6	-11
South Atlantic	6.2	77	-13	-10	77	-15	-8
East South Central	4.8	77	-14	-9	77	-12	-11
West South Central	2.3	90	-1	-9	82	-6	-12
Mountain	0.8	90	8	-19	90	-3	-7
Pacific	1.0	95	1	-6	103	-7	10

Note: Table shows regional average productivity/wage relative to national average. Index = 100 + industry-mix component + within-industry component.

[1]Share of national production worker hours. [2]Value-added per worker.

Source: Analysis of unpublished 1992 Census of Manufactures data.

Table 4. Regional decomposition of nonproduction worker annual salaries, 1992

Region	Employment share	Index	Component	
			Industry mix	Within industry
		Percent		
Metro				
Core	54.2	107	3	4
Fringe	2.6	93	-3	-4
Medium	22.9	99	0	-1
Small	6.8	88	-4	-7
Nonmetro				
Urbanized adjacent	3.5	87	-6	-8
Urbanized nonadjacent	1.7	80	-8	-13
Less urbanized adjacent	4.3	82	-8	-10
Less urbanized nonadjacent	3.1	76	-11	-13
Rural adjacent	0.4	73	-12	-15
Rural nonadjacent	0.5	67	-14	-18
Metro				
New England	6.3	109	1	8
Mid-Atlantic	15.3	108	1	7
East North Central	19.0	104	3	1
West North Central	5.6	99	2	-3
South Atlantic	11.4	98	0	-2
East South Central	3.3	90	-3	-7
West South Central	6.8	97	2	-4
Mountain	3.2	94	0	-6
Pacific	15.4	108	2	6
Nonmetro				
New England	0.7	87	-6	-8
Mid-Atlantic	1.0	85	-5	-10
East North Central	3.1	89	-6	-5
West North Central	1.8	76	-10	-14
South Atlantic	2.7	79	-10	-12
East South Central	2.0	76	-11	-13
West South Central	1.1	77	-8	-15
Mountain	0.6	76	-7	-17
Pacific	0.6	84	-11	-5

Note: Table shows regional average productivity/wage relative to national average. Index = 100 + industry-mix component + within-industry component

Source: Analysis of unpublished 1992 Census of Manufacturing data.

Table 5. Within-industry productivity and wage components and employment growth, 1991-93, by Beale code

Beale code	Within-industry components		Manufacturing employment growth	
	Productivity	Wage	Number	Rate
	Percent	*Percent*	*1,000*	*Percent*
Metro				
Core	4	5	-416.8	-5.0
Fringe	-1	-2	19.1	3.4
Medium	-1	2	-26.1	-0.6
Small	-1	-2	11.8	0.8
Nonmetro				
Urbanized adjacent	-2	-2	8.1	0.9
Urbanized nonadjacent	-8	-6	10.1	2.5
Less urbanized adjacent	-7	-9	51.6	3.8
Less urbanized nonadjacent	-11	-11	40.8	3.9
Rural adjacent	-11	-10	7.6	5.0
Rural nonadjacent	-14	-14	8.9	4.5
Metro				
New England	-2	6	-62.3	-6.2
Mid-Atlantic	3	5	-144.6	-6.0
East North Central	5	9	-12.2	-0.4
West North Central	5	4	-11.4	-1.3
South Atlantic	0	-4	-9.1	-0.4
East South Central	-3	-5	16.6	2.3
West South Central	8	-4	5.6	0.4
Mountain	-1	-4	15.0	2.8
Pacific	-1	2	-209.5	-8.2
Nonmetro				
New England	-12	-4	-4.6	-2.8
Mid-Atlantic	-8	-5	-7.7	-3.0
East North Central	-2	-5	34.4	4.2
West North Central	-4	-11	27.6	5.3
South Atlantic	-10	-8	21.6	2.3
East South Central	-9	-11	36.3	5.0
West South Central	-9	-12	13.8	3.6
Mountain	-19	-7	7.3	4.9
Pacific	-6	10	-0.9	-0.5
All	NA	NA	-284.3	-1.5

Source: Tables 2, 3, and unpublished Bureau of Economic Analysis employment data.

Figure 1. Nine census divisions

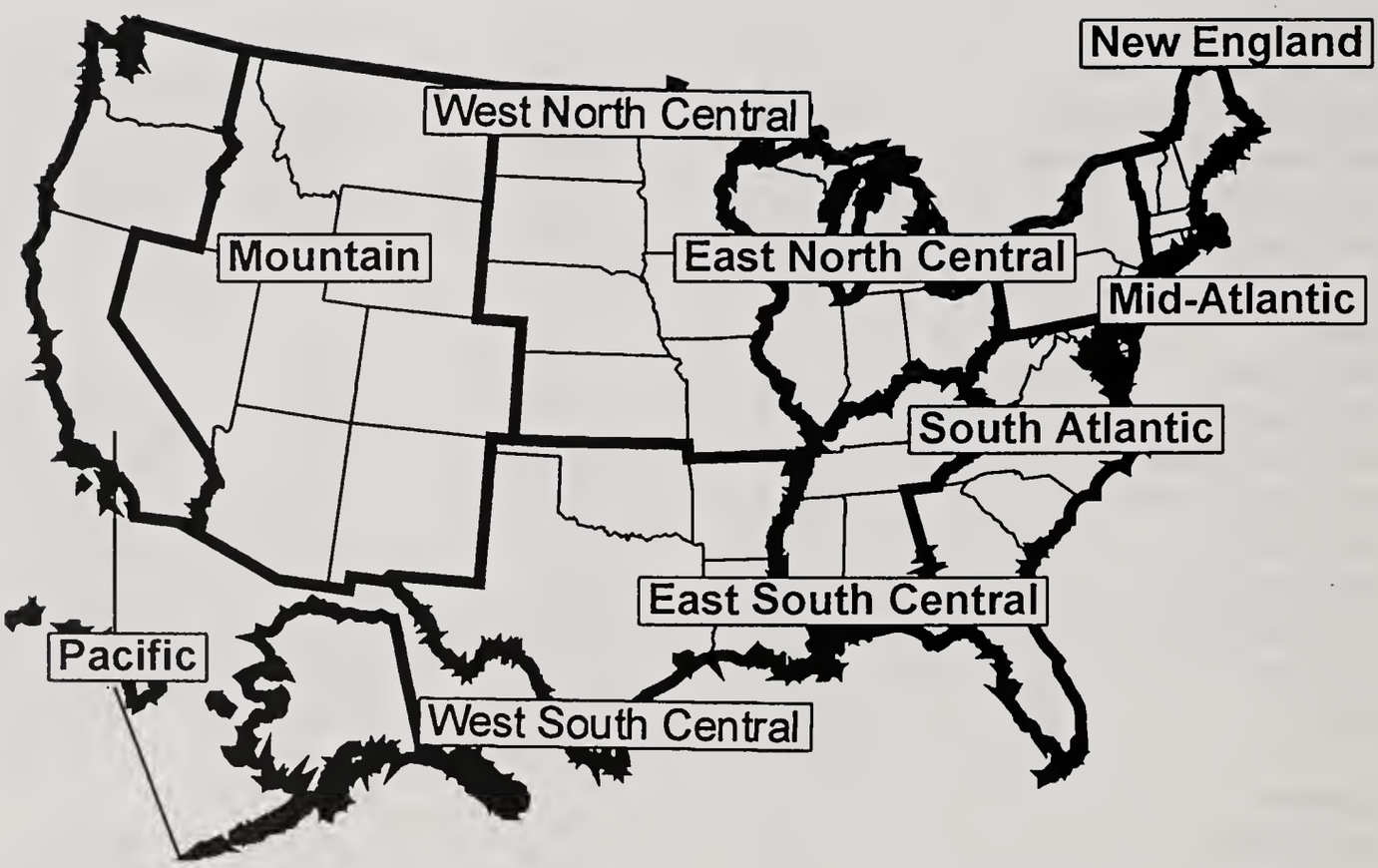
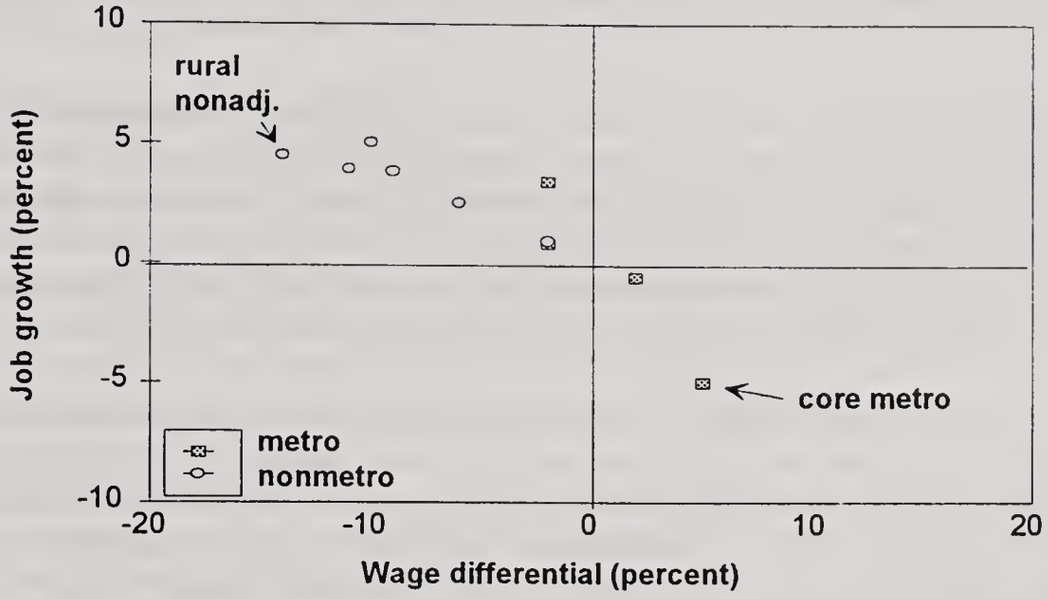
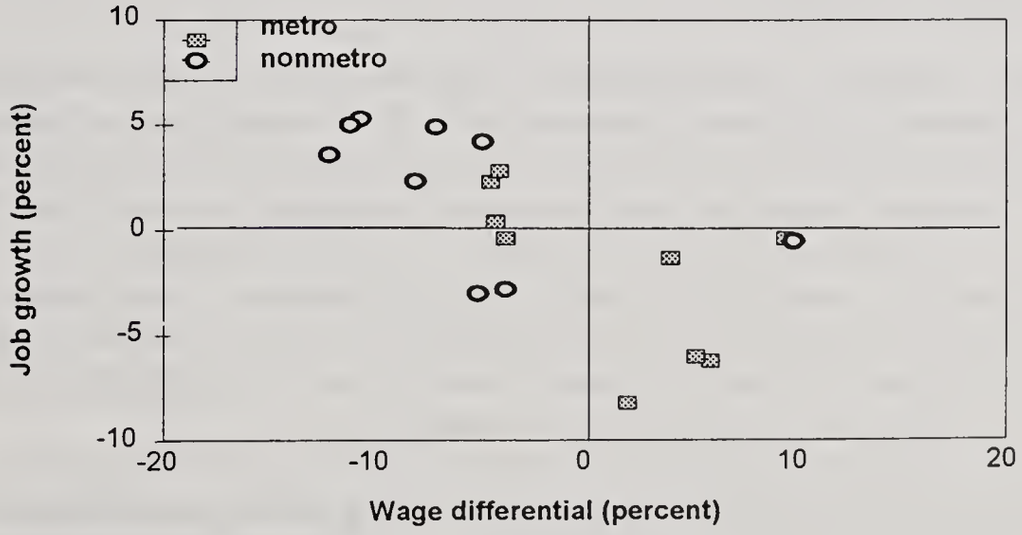


Figure 2. Relationship between manufacturing job growth and county Beale code, 1992



Source: Analysis of unpublished 1992 Census of Manufactures data.

Figure 3. Relationship between manufacturing job growth and wage differential, for metro-nonmetro portions of census divisions, 1992



Source: Analysis of unpublished 1992 Census of Manufactures data.

Appendix

Bias in Value-Added Comparisons Due to Excluding Purchased Services

Value-added reported in the Census of Manufactures is computed by subtracting the cost of materials, supplies, containers, fuel, purchased electricity, and contract work from the value of shipments (U.S. Bureau of the Census). This measures the dollar value-added by manufacturing activities at an establishment to raw materials and inputs provided by other establishments. The value-added measure does not subtract the value of "overhead" services (e.g., accounting, advertising, communications, consulting) that are not directly involved in production.

A number of researchers (most notably Ciccone and Hall) argue that the exclusion of services from the calculation renders the census value-added measure useless for comparison of rural and urban productivity. The argument is based on the assertion that urban establishments purchase more services from outside firms or headquarters, while more isolated rural establishments must provide the services internally. This suggests that the value-added measure tends to overstate the amount of production at urban establishments.

In this appendix, I take two approaches to evaluate this argument. First, I estimate the potential magnitude of the bias, assuming that all purchased services are used by metro establishments. Second, I examine data on the metro-nonmetro mix of nonproduction and production workers to explore the validity of the assertion that more services are purchased by metro plants.

Potential Magnitude of the Bias

I evaluated the magnitude of the purchased services bias on metro-nonmetro comparison of value-added per worker using a special tabulation of the 1992 Annual Survey of Manufactures (see Gale) and industry-level data on purchased services published in the 1992 Census of Manufactures. Purchased services for communications, accounting, advertising, legal, and software services combined amounted to 1.8 percent of manufacturing value-added, and ranged from 0.5 to 3.0 percent of value-added in individual 4-digit industries. Since Census of Manufactures services expenditures are only published at the industry level with no geographic breakdown, it is not possible to directly evaluate to what extent urban establishments spend relatively more on external services than rural establishments do.

I calculated the potential effect of the services bias by making the extreme assumption that all purchased services were used by metro establishments (in other words, nonmetro establishments purchased no services externally). With no correction for services bias, nonmetro value-added per worker is $68,100 and metro value-added per worker is $88,700, a metro-nonmetro ratio of 130 percent (appendix table 1). I then assumed that all purchased services were used in metro plants, and subtracted these expenditures from metro value-added. This adjustment reduced metro value-added per worker to $86,700. Consequently, the metro-nonmetro ratio was reduced to 127 percent. Within individual 2-digit industries, the ratio declined by 1 to 3 percentage

points (appendix table 2). From this exercise, I conclude that the bias due to exclusion of purchased services could account for at most 3 percentage points of the metro-nonmetro gap in productivity as measured by value-added per worker. After controlling for this potential bias, a considerable difference in productivity remains.

Production-Nonproduction Worker Mix

Again, the published data on purchased services are not published by geographic breakdown, and therefore do not permit a direct evaluation of whether metro establishments purchase more services than do nonmetro establishments. However, the assertion can be evaluated indirectly by comparing the mix of production and nonproduction workers in metro and nonmetro plants. (Production workers are those directly involved in production activities, while nonproduction workers include higher level supervisors and other "overhead" activities.)[6]

If metro plants purchase more services from outside the establishment, they should have fewer nonproduction workers employed to perform these functions. However, metro establishments actually have a much higher share of nonproduction workers. One-third of metro manufacturing workers are nonproduction workers, compared with only 21 percent of nonmetro manufacturing workers. Core metro establishments have 54 percent of all nonproduction workers, but only 39 percent of production labor. The greater share of nonproduction workers at metro establishments suggests that they actually produce more "overhead" services, including administration, sales and delivery, product development, etc.

In many multiestablishment firms, these "overhead" functions are often performed at urban establishments, while rural plants are devoted to direct production activities. Israilevich and Testa argue that these services add value to products, but the assignment of value-added by census value-added is based only on where physical production activities take place. Thus, the actual contribution to productivity at rural (nonmetro) establishments that are devoted to direct production activities may be *overstated* by the value-added measure and the productivity of urban (metro) plants may be *understated.*

---

[6]The census definition of production workers includes those engaged in fabricating, processing, assembling, inspecting, receiving, storing, handling, packing, warehousing, shipping, maintenance, repair, janitorial and guard services, product development, and recordkeeping. Production workers include line-supervisors, but employees above the working-supervisor level are excluded. Nonproduction workers include factory supervisors above the line-supervisor level, sales, delivery, advertising, credit, collection, installation and service personnel, clerical, executive, purchasing, financing, legal, human resources, professional, and technical employees. The Census Bureau reports data in auxiliary establishments that are not engaged in production separately, so the data analyzed here do not include administrative offices, warehouses, research and development labs, etc.

Summary

Ciccone and Hall and other analysts rule out the use of Census of Manufactures value-added data as a measure of regional productivity due to their assertion that urban (metro) establishments purchase more services externally than do rural (nonmetro) establishments. This alleged bias cannot explain the differential found in this study. If all purchased services were used by metro establishments, it would reduce the metro-nonmetro productivity differential from 30 to 27 percent. Further, the concentration of nonproduction workers in metro establishments suggests that the bias could actually be in the opposite direction. These data certainly have shortcomings, but this appendix shows that the magnitude of whatever bias may exist is relatively small.

Appendix table 1. Effect on metro-nonmetro productivity comparisons of excluding purchased services from manufacturing value-added

	Unit	Value
Purchased services as share of value-added[1]	Percent	1.8
Value-added per worker:		
Nonmetro	Dollars	68,100
Metro-no adjustment	Dollars	88,700
Metro-less purchased services	Dollars	86,700
Metro-nonmetro value-added per worker ratio		
With no adjustment	Percent	130
All purchased services in metro establishments	Percent	127

[1]Communications, accounting, advertising, legal, and software services.

Source: Calculations using 1992 Census of Manufactures and special tabulation of 1992 Annual Survey of Manufactures.

Appendix table 2. Metro-nonmetro productivity ratio by industry, with and without adjustment for purchased services

Industry	SIC code	Without adjustment	With adjustment[1]
		Percent	
Food and kindred	20	156	153
Tobacco products	21	229	227
Textile mill products	22	96	95
Apparel and other textile products	23	124	121
Lumber and wood products	24	92	89
Furniture and fixtures	25	109	106
Paper and allied products	26	82	81
Printing and publishing	27	142	138
Chemicals and allied products	28	112	109
Petroleum and coal products	29	120	118
Rubber and miscellaneous plastics	30	97	96
Leather and leather products	31	113	108
Stone, clay, and glass products	32	101	100
Primary metals	33	109	108
Fabricated metal products	34	101	99
Industrial machinery and equipment	35	118	115
Electronic and other electrical equipment	36	121	119
Transportation equipment	37	122	119
Instruments and related products	38	111	108
Miscellaneous manufacturing	39	98	94

[1]Adjustment assumes that all purchased services were used in metro establishments.

Source: ERS calculations based on unpublished 1992 Census of Manufactures data.